National Research Council Canada
Conseil national de recherches Canada

CAD/CAM Activities at NRC

NRC CAD/CAM Interest Group

March 1986

Canada

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INTRODUCTION

As a result of a meeting held on 8 February 1984 at the National Research Council of Canada there was a consensus to form a CAD/CAM Interest Group.

The CAD/CAM Interest Group is intended to be a way of grouping people at NRC sharing a common interest in CAD/CAM and Robotics technologies, to provide a communication forum in order to share experience or expertise, and to provide a means for encouraging cooperative efforts and thinkings.

More than 50 persons at NRC are currently involved in various projects which include CAD/CAM and Robotics aspects in the following Divisions or Institutes of NRC: Division of Building Research, Computer Center, Division of Electrical Engineering, Herzberg Institute of Astrophysics, Industrial Materials Research Institute, Institute for Marine Dynamics, Division of Mechanical Engineering, National Aeronautical Establishment.

Therefore, it was felt that it would be of interest to identify these projects and to prepare a list of them with a short description, a contact person, and the resources involved. Such a document can be useful to NRC people, of course, but also to others who would like to know about projects going on at NRC in this field and whom to contact regarding specific expertise.

We hope that this document will satisfy this purpose. However, to remain a useful tool this document must be updated regularly (say each year). Therefore, we kindly ask members of the NRC CAD/CAM Interest Group to indicate any corrections or additions to the contents of this brochure to Bert Van den Berg (613-993-1474) or to François Vernadat (613-993-2007).

A companion brochure, entitled "NRC Publications on CAD/CAM and Robotics" is also available from the NRC CAD/CAM Interest Group, from B. Van den Berg or F. Vernadat.

F.B. Vernadat

PRÉFACE

A la suite d'une réunion tenue le 8 février 1984 au Conseil national de recherches du Canada, il fut convenu de former un Groupe d'Intérêt sur la CFAO (Conception et Fabrication Assistées par Ordinateur).

Le Groupe d'Intérêt sur la CFAO a pour but de réunir les personnes du CNRC patageant un intéret commun au sujet de la CFAO et de la Robotique, de fournir un lieu de communication pour échanger des expériences ou des expertises et de fournir une opportunité pour encourager les efforts et les réflexions en commun.

Plus de 50 personnes sont actuellement impliquées dans divers projets du CNRC touchant à la CFAO ou à la Robotique dans les Divisions ou Instituts suivants du CNRC: Division de recherches en bâtiment, Centre de calcul, Division de génie électrique, Institut Herzberg d'astrophysique, Institut de génie des matériaux, Institut de dynamique marine, Division de génie mécanique, Etablissement aéronautique national.

Ainsi, il a semblé opportun d'identifier ces projets et de les regrouper dans une brochure donnant pour chacun une courte description, une personne à contacter et les ressources impliquées. Un tel document peut être utile au personnel du CNRC bien entendu, mais aussi à d'autres personnes qui souhaiteraient savoir quels projets existent dans ce domaine et qui contacter.

Nous espérons que ce document satisfera ce besoin. Cependant, afin de rester utile ce document devra être remis à jour régulièrement (disons à chaque année). Aussi, nous demandons aux membres du Groupe d'Intérêt sur la CFAO du CNRC de bien vouloir signaler toute correction ou addition nécessaire à faire à ce document en contactant Bert Van den Berg (613-993-1474) ou François Vernadat (613-993-2007).

Une autre brochure, appelée "NRC Publications on CAD/CAM and Robotics" est également disponible auprès de B. Van den Berg ou F. Vernadat.

F.B. Vernadat

Division: Building Research

Section : Building Services

Project title: Benchmark procedure

Project leader: D. Vanier Phone no: 613-993-9699

Project description:

Benchmark procedure to evaluate Computer-Aided Design and Drafting systems for building industry applications.

A formalized procedure has been developed to assist purchasers in the evaluation of CADD systems. The CADD Benchmark is designed to test most drafting features, as well as a number of more complex operations including: area calculation, bills of material, and data base manipulation. The Benchmark is directed at facilities management, but the software features tested cover a wide variety of drafting requirements: plotting, zooming, dimensioning, scaling, rotation, filing, and symbol creation. It is designed to be administered by the architect/engineer, but all of the keyboard and graphic entry is made by the hardware/software vendor as per instructions and guidelines from the Benchmark. A Benchmark Baseplan is provided one week prior to the test date and the vendor inputs the requisite information. On the Benchmark date the purchaser will be able to view the software package in operation with the vendor following a series of CADD tasks as established in the Benchmark. Timings and data storage requirements are recorded by the purchaser and the results can be quantified and compared with the results of other Benchmarks. The Benchmark also allows the purchaser to subjectively rate CADD packages, based on functionality and ease of use. This Benchmark was published as an NRC publication in Summer 1985 (Building Practice Note #58).

Resources:

Persons:

Hardware:

Software:

External cooperation (if any):

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Division: Building Research

Section: Building Services

Project title: CSA Standards

Project leader: D. Vanier Phone no: 613-993-9699

Project description:

The Division of Building Research is actively participating in the creation of a standard for CADD. The goal of CSA 78.5 is to provide a standard for the construction industry that will reflect the new requirements of CADD. The standard applies to the computer-aided preparation and reproduction of construction drawings. In general context it establishes detailed recommendations on implementation and symbology for computer-aided design drafting in construction. The membership of the Committee consists of building practitioners, standards personnel, CADD vendors, and design drafting educators. There are approximately fourteen members in the various working groups and an additional thirty members on the corresponding members list. The Committee was formed in 1984 and a draft version of the standard is now available for comment; the standard will be completed in Summer 1986.

The basic philisophy and requirements placed upon the CADD system are to make the drawings readable to all those who will use the drawings. Therefore, traditional drawing conventions must be followed and CADD must not alter accepted practice; but still should employ equipment advantages whenever possible. CSA 78.5 will relate to existing international standards such as the Initial Graphics Exchange Specification (IGES) and the Graphics Kernel System (GKS). A parallel layering structure for application-based standards must exist to allow transfer of information from one CADD system to another.

In addition, the International Standards Organization (ISO) has recently formed an equivalent body dealing with Computer Graphics for Technical Drawings and members of DBR are actively participating in this committee. It is hoped that the work of the CSA 78.5 will affect the direction of this new international standard.

Resources:

Persons:

Hardware:

Software:

External cooperation (if any):
Canadian Standards Association

Division: Building Research

Section : Building Services

Project title: Geometric modelling for buildings

Project leader: D. Vanier Phone no: 613-993-9699

Project description:

The objective of this project is to investigate the geometric modelling requirements of the designer and the potential opportunities in the building delivery system. Work has been completed on the use of geometric modellers and the visual representation of shapes; future considerations for research will include modelling of component-based systems and will include recommendations for development of modelling tools for building design.

Resources:

Persons: 0.4 py

Hardware:

Software:

External cooperation (if any):

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Division: Building Research

Section : Building Services

Project title: Integrated Computer-Aided Design

Project leader: D. Vanier Phone no: 613-993-9699

Project description:

The International Commission on Building Research and Documentation (CIB) Working Commission W-78, Integrated Computer-Aided Design, has conducted a study to develop a catalog of integrated CAD systems. The goal of the study is to detail major integrated CAD systems and to identify those under development. An integrated system for building design is defined as one offering multi-discipline (architectural, civil, mechanical, electrical, structural) design analysis, drawing production, specification development, and estimating support in a shared environment. The survey is completed and will be available in Summer 1985. However, the survey is still in progress and companies wishing to contribute should contact Dana Vanier as soon as possible.

Resources:

Persons:

Hardware:

Software:

External cooperation (if any):

Division: Computer Center

Section :

Project title: Computer Center CAD/CAM Support

Project leader: Phone no: 613-993-0240

Project description:

I) Graphics output devices available (can be accessed from Unigraphics/ Divisional VAX's via Decnet):
   1) 36" 4-pen drum plotter (liquid ink pens on Vellum paper for CAD)
   2) 8 1/2" x 11" b&w 300 dpi laser printer/plotter
   3) 35 mm very high resolution (4000 x 3000 line) film recorder for producing slides
   4) 8 1/2" x 11" colour high resolution (154 dpi) ink-jet plotter for fast shaded output

II) IBM based software:
   1) NISA - finite element, structural and heat analysis package (similar to NASTRAN and ANSYS)
   2) TEX package for typesetting technical reports and documents (soon will provide facility for embedding anu plot output within the typset document)

III) Under consideration to provide the following on a CC VAX:
   - Unigraphics 3D CAD
   - multiDRAW 2D drafting package (Cymbol Cybernetics)
   - 36" b&w electrostatic plotter

IV) Work in progress on index of all available software at NRC (Divisional VAX's and CC)

Resources:

Persons:

Hardware: see above

Software: see above

External cooperation (if any):

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Division: Electrical Engineering

Section : Computing Technology

Project title:

Project leader: N. Burtnyk Phone no: 613-993-0261

Project description:

The Computer Graphics Section research program includes work in three areas of computer applications in manufacturing - robotics, graphics, and image processing. The orientation of these activities is towards the long term in the form of core support for future generations of automation technology.

In our approach, we look at robotics from the point of view of sensor-based control of a complex real-time system, with a primary interest in how to express this control in terms of viable computer systems. One aspect of our research has emphazised the development of a multiprocessor computing architecture capable of servicing the real-time processing requirements of a multi-sensor control system. Building on this architecture, we have highlighted some difficult problems in real-time control as a focus for experimentation with robots and sensors. More recently, a component of artificial intelligence research has been added to exploit a knowledge-based approach to sensory decision making.

The research in computer graphics involves the investigation of advanced techniques in graphical communication and their application to workstation development. The current focus of this effort is towards a simulation workstation for robotics task planning.

The image processing research involves the development of new knowledge in image analysis and recognition and its application to problems in computer vision, with recent increasing emphasis on robotics vision.

Resources:

Persons:

Hardware:

Software:

External cooperation (if any):

Division: Electrical Engineering

Section : Computing Technology

Project title: Robot arm workspaces

Project leader: P. Tanner Phone no: 613-993-6553

Project description:

In conjunction with researchers in Montpellier, France, a system has been developed that finds the searchable workspaces of robot arms in a given posture. The workspaces for all the postures can be combined to give the full workspace of the arm, or they can be used individually to better understand the mobility of the arm.

Resources:

Persons: 1.1

Hardware: IBM 3083 with IBM display

Software: CATIA

External cooperation (if any):
Most of the work done by people in Montpellier; some done by P. Tanner

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Division: Electrical Engineering

Section : Photonics and Sensors

Project title:

Project leader: J. Domey Phone no: 613-993-2557

Project description:

The objective of the Photonics and Sensors Section's projects is to develop new sensor systems, related to automation, combining optical, electronic and computer techniques. There are presently two related activities: (1) tridimensional vision and (2) guided optic techniques for sensors and signal processing.

The research on 3-D vision involves the development of new optical techniques for accurate and fast acquisition of 3-D data from a scene and the processing of this data for object recognition.

The guided optics research involves investigation of integrated optics, fiber optic and non-linear optic techniques to realize new sensors and high speed signal processing elements and systems.

Resources:

Persons:

Hardware:

Software:

External cooperation (if any):

Division: Electrical Engineering

Section : Photonics and Sensors

Project title: Interfacing a 3d vision sensor with a CAD/CAM system

Project leader: P. Boulanger Phone no: 613-993-1426

Project description:

- Development of a solid digitizer using the scanning laser probe technology;
- Interfacing of the data with a standard CAD/CAM system;
- Development of software modules to represent and modify digitized solid objects (solid model editor);
- Reproduction of objects on an NC milling machine.

The objective of this project is to develop and integrate these elements into a system that will digitize 3-D surface coordinate of objects, and, after filtering and editing, supply data in the proper form for NC machining.

Resources:

Persons: P. Boulanger, P. Chartier, L. Cournoyer, M. Rioux, L. Rulhman

Hardware: VAX 11/750, 3D vision sensor

Software: solid model editor, filtering software, Polyhedral NC

External cooperation (if any):

Hymarc Engr.

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Division: Electrical Engineering

Section : Information Science Section

Project title: Computer-based design models

Project leader: Dr. K.P. Lam Phone no: 613-993-2007

Project description:

To study computer-aided design with a focus on development of computer-based models to assist in the design decision process. Three research topics have been identified and pursued:

- the study of specific layout and routing algorithms for two-dimensional layout;
- the theoretical development and simulation study of contour-map processing and self-position determination algorithms;
- the study of parameter identification and digital control.

Resources:

Persons: 1

Hardware: ORCATECH 2000, Data General MV 8000

Software: in-house developed packages (in FORTRAN)

External cooperation (if any):

Division: Electrical Engineering

Section : Information Science

Project title: Database systems for Computer-Aided Design and Manufacturing

Project leader: Dr. F.B. Vernadat Phone no: 613-993-2007

Project description:

The objective is to consider database technology and its applications to the field of CAD/CAM and CIM and transfer our expertise to Canadian industry. Major accomplishments of this project involve:

- the publication of a large bibliography on CAD/CAM database research "A Commented and Indexed Bibliography on Data Structuring and Data Management in CAD/CAM: 1970 to Mid-1983". F.B. Vernadat, ERB-956, National Research Council Canada, Division of Electrical Engineering, Ottawa, Ont., March 1984.
- the development of a multi-database/multi-user database system called DBS/R and available on DEC VAX 11 and DG MV 8000
- the development of a complete CIM database schema for discrete parts manufacturing
- the development of a demonstration package for Master Production Scheduling (MPS) based on sales forecasts and customer demand

On-going work includes:

- the development of efficient integrity control mechanisms for DBS/R
- the translation of DBS/R code into C for the DEC MicroVAX computer in a flexible manufacturing environment (in cooperation with MTC)
- the development of a logical database design methodology for developing manufacturing applications

Resources:

Persons: A. Famili, G. Gratton, W. Henneker, F. Vernadat, R. Wylie

Hardware: Data General MV 8000, DEC VAX 11/780

Software: Pascal, C, DBS/R

External cooperation (if any):
University of Turino, Italy
E.B. Eddy Forestry Products, Powrmatic Canada
Technologie Ordinateur Outaouais
Les Systemes Info Jonathan Inc.

Division: Electrical Engineering

Section : Information Science

Project title: Engineering Information Systems

Project leader: Dr. F.B. Vernadat Phone no: 613-993-2007

Project description:

Database Systems are only part of the solution for total integration as required by computer-integrated manufacturing systems (CIMS). As more and more artificial intelligence techniques will be used in CIM, a great deal of knowledge, rules, constraints, etc., has to be stored and managed in addition to conventional data. Moreover, the various components of the CIM system require short access times and they will operate in a distributed environment. Therefore, it is proposed to develop Engineering Information Systems based on database systems, knowledge-base systems, and local area networks techniques.

Currently, we are developing version 1 of the EIS software package, a mono-user expert database system with its associated 5th generation language. Experiments are being done for manipulating complex data such as text, signals, and images as well as production rules with such a system. Other activities involved in this project include the development of various expert systems for manufacturing applications (such as work sampling, manufacturing cell scheduling, ...) and the development of expertise for building knowledge bases in manufacturing environments.

Also, various inference engines, knowledge acquisition, and knowledge representation mechanisms are required in an EIS. Part of this project is devoted to investigate such tools and their implementation languages. Rule-based systems have been written using Pascal and LISP.

Resources:

Persons: P. Davidson, A. Famili, W. Henneker, K. Lam, F. Vernadat, R. Wylie

Hardware: Data General MV 8000, IBM PC AT, Orcatech 2000

Software: Pascal, C, DBR/R, LISP, Prolog, UNIX environment

External cooperation (if any):
Carnegie-Mellon University
University of Grenoble, France
Ecole Polytechnique de Montreal

Division: Electrical Engineering

Section : Laboratory for Intelligent Systems

Project title: CAD/CAM Newsletter

Project leader: J. Scrimgeour Phone no: 613-993-9008

Project description:

The CAD/CAM Newsletter, which began monthly publication in August 1979, is now receiving by close to 3000 persons across Canada who have requested receipt on regular basis. It provides a world watch service on events and developments in CAD/CAM and Computer Integrated Manufacturing and is a major technology transfer activity originating within NRC.

Although translation, printing and distribution of the Newsletter is handled by the Department of Regional Industrial Expansion, who also currently provides the secretariat for the Canadian CAD/CAM Council, the Newsletter is delivered to them each month in camera-ready form by J. Scrimgeour, who has been editor of the Newsletter since it began in 1979.

Resources include members of the CAD/CAM Council and a wide network of information sources.

Requests to receive the Newsletter should be directed to the secretariat as follows:

Secretariat
Canadian CAD/CAM Council
Office of Industrial Innovation, 5th Floor Centre
Department of Regional Industrial Expansion
235 Queen Street
Ottawa, Ontario K1A 0H5
Telephone: 995-3741

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Division: Herzberg Institute of Astrophysics

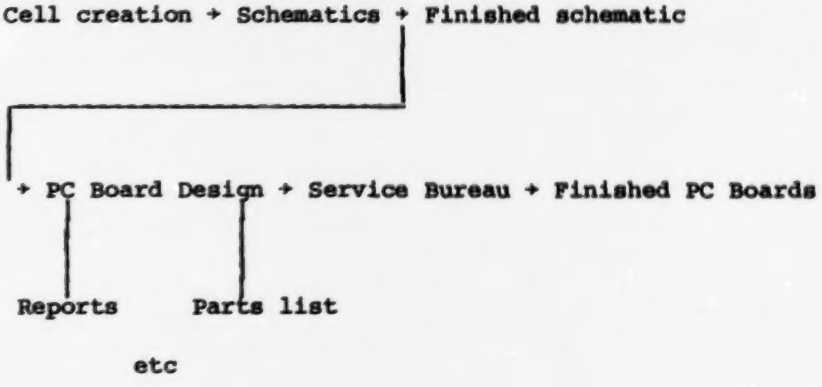
Section : Astronomy

Project title: Btest site for ORCA 1000. PCB design system

Project leader: J. R. Fletcher Phone no: 613-993-6060

Project description:

Complete design system from original idea stage for PC Boards


Cell creation → Schematics → Finished schematic
→ PC Board Design → Service Bureau → Finished PC Boards
Reports
Parts list
etc

Resources:

Persons: 6 involved in Btest site (users)

Hardware: ORCA 1000, HP 7550 plotter, HITACHI color CRT

Software: SEDIT, CEDIT, TRAX, AutoTRAX, OGS Graphics System

External cooperation (if any):

Division: Industrial Materials Research Institute

Section : Systems and Instrumentation

Project title: CAD/CAM in Materials Forming Processes

Project leader: Georges Salloum Phone no: 514-641-2280

Project description:

Modelling and simulation of materials behaviour under processing and service conditions. Present activities cover moulding, casting and forming processes.

Development of computer-integrated software for the design and manufacturing of products and tools specific to these processes.

Resources:

Persons: 10

Hardware: DEC VAX 11/785 under VMS, Applicon workstations

Software: Applicon's Bravo software, special application software

External cooperation (if any):
Insitut fur Kunststoffverarbeitung, Aachen, FRG
Battelle Columbus Laboratories, Columbus, Ohio, USA
McGill university, Montreal
Industrial partners: I.P.L., I.T.L., CANALLOY, BNR, FISHER CAST, UNICAN, LYSTER, Electrolux. etc.

Division: Institute for Marine Dynamics

Section : Research and Development

Project title: Ship Model Production Facility

Project leader: T. Randell Phone no: 709-772-5012

Project description:

To provide facilities for the automated construction of ship models using Line's 5-axis Milling Machine. The machine is of a moving gantry type, five axes, one 5 HP spindle head, maximum speed 6 m/mn, working envelope of 12 m × 2.8 m × 1.8 m. The controller is an Allen Bradley 8200. Machine installation was completed in October 1985. A faired set of Ships Hull lines are created on a VAX 11/750 from which the NC cutting file is developed. NC data are sent to a satellite LSI 11 computer for buffering and processing before it is sent to controller via DNC link. Modified version of previous software from M22 in Ottawa allowing 4-axis milling is used at present. Five-axis software is being developed.

Resources:

Persons:

Hardware: VAX 11/750, LSI 11/23+ (RT103), LINE CNC Milling Machine, Tektronix 4114, 4054, 4662, and 4611, Calcomp 1073 plotter, Gentian Digitizer

Software: VMS, FORTRAN, RT11sj, MACRO11, DECNET

External cooperation (if any):

Division: Mechanical Engineering

Section : Manufacturing Technology Centre

Project title: Computer-Aided Manufacturing and Design at MTC

Project leader: B. Van den Berg Phone no: 613-993-1474

Project description:

The Manufacturing Technology Center is involved in the application of computers to manufacturing and design of mechanical components. The Center produces conceptual designs, laboratory test equipment, and precision sculptured surface parts.

To support these activities MTC is using a Unigraphics CAD/CAM system. The system includes two color workstations running off the M3 VAX 11/780. The software is an integrated system for design, drafting and generation of NC toolpaths. Design prints are made using the Computation Center's pen plotter.

In conjunction with Unigraphics, a software package from ICAM Technologies is being used to translate APT program output of Unigraphics into the NC programs that the machine tools require. The system includes a post-process generator and general post-processing software that allows NC programs to be created for a variety of machines. MTC is working with ICAM to debug the 5-axis machining capabilities of the post-processor.

A system is being developed to integrate Unigraphics with our Coordinate Measuring Machine. A simple method has been developed to create measurement programs for sculptured surface parts using Unigraphics. Work is underway on software to load the measurement result back into the Unigraphics database, and provide some analysis of the measurements.

Resources:

Persons: 6

Hardware: VAX 11/780, Wahli W51, Brown and Sharpe 8202
Unigraphics workstations

Software: Unigraphics, INGRES

External cooperation (if any):
ICAM Technologies

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Division: Mechanical Engineering

Section : Systems Laboratory

Project title: Adaptive Manufacturing Cell

Project leader: Dr. P.W.U. Graefe Phone no: 613-993-9459

Project description:

An adaptive manufacturing cell project is going on at DME.

Components in the cell are:

1 - Wahli Minormatic W51 5 axis machining centre

2 - Baxter Technology 1440 turning centre

3 - ASEA Rb60 robot

4 - Brown and Sharpe 8202 Coordinate Measuring Machine

5 - Cell controller. 68000 based Chorus machine with Harmony operating system

The first milestone in the operation of the cell will be the following:

The robot is to pick up a suitably prepared turbine blade blank from a shelf and place it in a fixture on the machining centre. The machining centre will then commence machining the blade, calling on the robot for tool changes as requested by the NC programs. At the completion of the machining operations the robot is to unload the finished blade from the fixture and place it in a specified storage area.

An overview of the facility is shown on the next page.

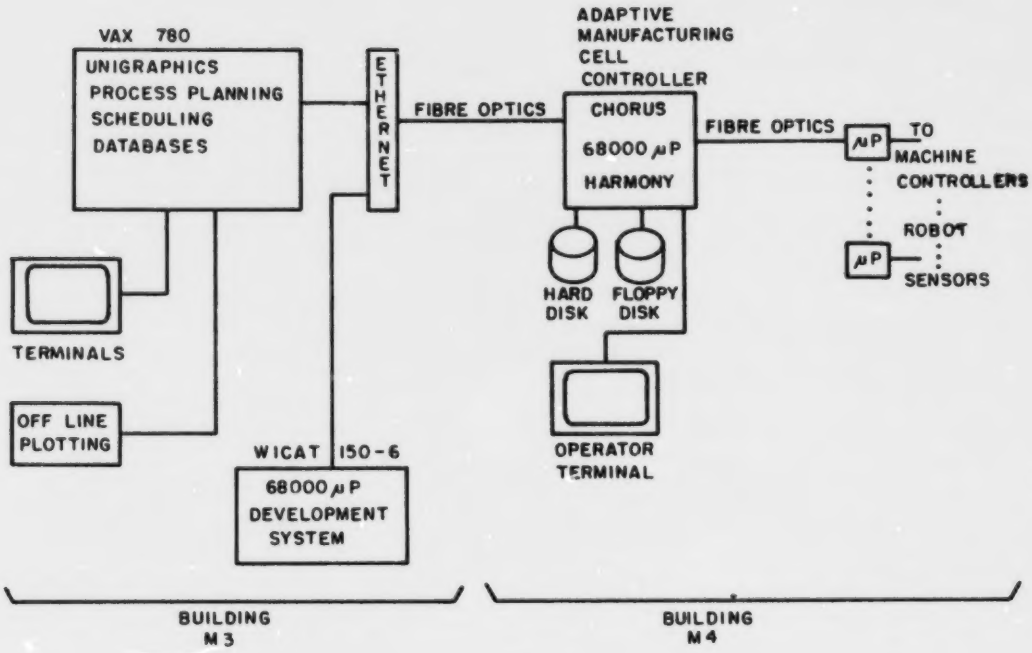
Resources:

Persons: 4

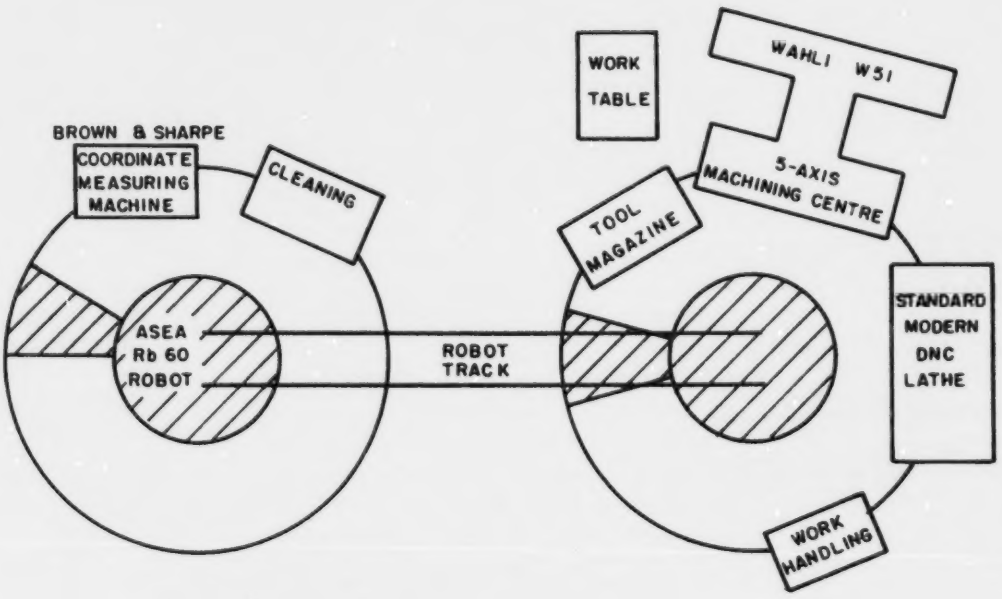
Hardware: see above

Software: Unigraphics, C, Harmony

External cooperation (if any):



DME CAD/CAM FACILITY AND MANUFACTURING CELL



ADAPTIVE MANUFACTURING CELL

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Division: Mechanical Engineering

Section : Systems Laboratory

Project title: Flexible Manufacturing Cell

Project leader: A.A. Merabet Phone no: 613-993-9438

Project description:

Analysis, design, development and testing of computer-integrated manufacturing functions in a flexible cell

Resources:

Persons: 1

Hardware: CHORUS machine

Software: Harmony, C

External cooperation (if any):

Division: Mechanical Engineering

Section : Systems Laboratory

Project title: Development of a generic jobshop scheduler and modeller

Project leader: V. Thomson, U. Graefe Phone no: 613-993-9461

Project description:

The Systems Laboratory, in collaboration with ICAM Technologies Corp., Montreal, is currently in the process of developing a Manufacturing Planning System which will provide an integrated scheduling and production management tool for small to medium sized manufacturing job shops. The system schedules jobs, allows modelling of a job shop and provides for manufacturing information management.

The Manufacturing Planning System is composed of five major modules:

- the scheduler, producing detailed shop schedules, as well as master production plans
- the modeller, able to simulate in detail the running of a given schedule or to be used to to evaluate 'what-if' type situations
- the shop monitor which updates the manufacturing database
- the user interface, a menu driven access system with advanced graphics display routines
- the database interface for accessing the manufacturing database or any other databases supported by the user

Resources:

Persons: 6 (NRC), 8 (ICAM)

Hardware: VAX 11/780, VS11, TEK 4107

Software: PROVUE, INGRES, RDB, USE.IT, ANEVENT

External cooperation (if any):

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Division: National Aeronautical Establishment

Section : High Speed Aerodynamics Laboratory

Project title: Wind Tunnel Model Design

Project leader: Dr. Dennis Brown Phone no: 613-998-3426

Project description:

1) Contour definition of model via transfer of digitised and mathematically smoothed data from TSS to CAD;

*2) Concurrent with 1), detail design and definition of constituent parts for built-up construction of model, including pressure instrumentation and plumbing requirements;

*3) Preparation of detail and assembly drawings;

4) Data processing for NC mill production of parts;

5) Manufacture and instrumentation of model;

* As presently envisioned, some of the design and drafting effort will be performed manually due to the distribution of work-load and availability of only one CAD/CAM terminal.

Resources:

Persons: 1 Aerodynamicist, 1 Mathematician, 2-3 Designers,
1 Shop foreman, 1-4 Toolmakers, 1-4 Technicians.

Hardware: 1 McAuto D-120CE Design Station, 1 VAX 11/780 computer
1 Cincinnati vertical profiler, 1 MAHO MH-700C and
1 Deckel FP-42NC CNC milling machine.

Software: Unigraphics + some custom software by Dennis Jones

External cooperation (if any):